## EVALUATION OF AMMONIA-N MASS DISCHARGE AFTER REFINERY RECONFIGURATION AND USE OF CXHO

The evaluation has been conducted using:

- monitoring data on BP Whiting Refinery Lakefront wastewater operations to define ammonia removal efficiency
- information from EPA[1]
- information on BP Whiting, BP Toledo, and BP Cherry Point Refinery sour water stripper performance
- information on Canadian heavy crudes[2]

To avoid overstating ammonia effluent concentrations, evaluations of technology-based discharge limits and WWTP performance are based on long term averages and monthly averages, not maximum or minimum values.

### WWTP Ammonia Removal

The Lakefront WWTP is not specifically designed to degrade (nitrify) ammonia, however conditions do exist in the aeration tank that allow the growth of nitrifiers and the mass of these nitrifiers has been effective in degrading ammonia. The removal efficiency used for this Anti-Deg Analysis has been developed as follows[3]:

- Influent: 1,668 lb/d Long-Term Average (2003-2005 operational data)
- Influent: Assume that the 2003-2005 influent mass is equivalent to 2001-2002 influent mass
- Effluent: 502 lb/d Maximum Monthly Average (2001-2002 DMR)

➢ Ammonia Removal Efficiency (RE) % = (1,668-502) / 1668 = 70% (as an ‘average’)

### Post-CXHO Ammonia Mass

<u>Additional Coking, Hydrotreating, Alkylation impact on effluent ammonia increase based on EPA information</u>.

The current monthly average ammonia discharge limit is 1,030 lb/d, which was developed for the refinery in 1974 and carried forward to the current permit. The ELG limit of 2,971 lbs/day (Table 2 of Anti-Deg Analysis) for ammonia is based on the existing refinery configuration at 420,600 bbls/d, prior to the CXHO reconfiguration. The ELG limit being requested for CXHO configuration is 3,358 lbs/day (based on 420,000 bbls/d) as summarized on Table 6 of Anti-Deg Analysis. This limit is below the Water Quality Based Effluent Limits (WQBELs) for ammonia-N.

The 3,358 lb/day limit for ammonia is determined from the post-CXHO reconfiguration and process unit feedrates (as per Best Available Technology established in 40 CFR 419). As described in the Anti-Deg Analysis, since utilization of CXHO will result in increased coker production, increased hydrotreating, and increased alkylation, the effluent mass discharge of ammonia is expected to be increased according to EPA ELGs for "best" refinery control technology.

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[1] Development Document for Petroleum Refining ELGs
[2] http://pubs.usgs.gov/fs/fs070-03/fs070-03.html

[3] As noted in the Anti-Deg Analysis, due to increased frequency of recycle of the effluent prior to Outfall 001 in 2003 to 2005, effluent data from 2001 to 2002 are used.

Using the EPA assessment of refineries employing Best Available Treatment technology, increasing crude processing and doubling cracking and coking capacity should result in a 226 percent increase in effluent ammonia mass from currently permitted levels.

<u>Additional Nitrogen Load to Process Wastewaters from Change in Crude Slate based on quality on Canadian extra heavy crudes.</u>

The request to increase ammonia limits to CXHO ELG levels (i.e., 3,358 lb/d monthly average ammonia) is also necessary given that crude slate Nitrogen (N) levels will change using Canadian crudes. The CXHO crude slate is expected to contain 4.5 times more N than the existing crude slate. This percent increase is determined from the nitrogen content of bitumen and the nitrogen content of West Texas Intermediate (WTI) crude. Throughout our CXHO investigation process, BP, ADVENT-ENVIRON, and others have used WTI as the “catch-all” for the current crude slate. The oil properties database from Environment Canada’s Environmental Technology Centre reports WTI nitrogen content at 0.08 percent (800 ppm)[4]. Information from the Oil Sands Discovery Centre presents the nitrogen content of bitumen at 0.36 percent (3,600 ppm), a 350 percent increase [or 4.5 times].[5]

The bulk of the N will end up as ammonia in sour water. The primary function of the sour water system is to remove/recover hydrogen sulfide. Since the system is not specifically designed to remove / recover ammonia, it is anticipated that the ammonia in the stripped sour water will increase as a result of the change in crude slate from existing configuration to CXHO configuration. However, exact percent increases are not known. There are no data available on what percent increase could be anticipated due to a change in crude slate. For this analysis, ADVENT-ENVIRON has assumed a sour water stripper bottoms ammonia-nitrogen concentration of 80 mg/L. [6] Using currently configured sour water strippers with a flow of 750 gpm at 30 mg/L[7] ammonia-N and a post-CXHO flow projected to be 2500 gpm at 80 mg/L, an increase of 2,131.7 lb/d ammonia-N in process wastewater is anticipated due to the quality of the CXHO crude slate.

<u>Ammonia-N Influent Mass Calculation</u>

Projected Influent based on change in refinery configuration, which is calculated based on the Lakefront Long-Term Average Influent adjusted for EPA ELG for BAT Monthly Average Percent Increase:

1,668 lb/d * 226% increase = 5,437.7 lb/d ammonia-N

Additional Influent Ammonia-N based on CXHO crude slate:

2,131.7 lb/d ammonia-N

Projected post-CXHO Influent Ammonia-N (based on refinery configuration + change in crude slate with CXHO)

5437.7 lb/d + 2131.7 lb/d = 7,569.4 lb/d

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[4] *Environmental Technology Centre ( www.etcentre.org/databases/oilproperties/default.aspx ),* Oil Properties Database, West Texas Intermediate, Environment Canada, 2001.
[5] *Bitumen Fact Sheet*, Oil Sands Discovery Centre, Alberta, Canada.
[6] Sour water stripping performance relative to ammonia varies as a function of capacity (e.g., steam, temperature) and pH (e.g., point of addition of caustic). Based on the sour water configuration for the BP refineries, ammonia content can vary from 10 mg/L to 80 mg/L. Based on ADVENT-ENVIRON experience with similar sour water stripper operations, ammonia-N can vary from 30 mg/L to 100 mg/L.
[7] Current refinery SWS flows and ammonia-N levels presented in Table 10 of Anti-Deg Analysis.

Post-CXHO Projected Effluent Mass

- Projected Influent = 7,569.4 lb/d
- Removal Efficiency = 70% (as an average)

➢ Effluent Mass = 2,270.8 lb/d ammonia-N

Historically, BP has operated the Lakefront WWTP to achieve an effluent quality for BOD, COD, phenolics, oil & grease, and ammonia that is between 10 percent to 40 percent of monthly average discharge limits. Only TSS has been managed with a lower margin of safety, with an effluent quality between 60 to 80 percent of monthly average discharge limits. The projected post-CXHO ammonia of 2,271 lb/d is 68 percent of the monthly average BAT discharge limit.

**Lakefront WWTP Options to Attain Current Ammonia-N Discharge Limits**

Technically viable treatment to further reduce ammonia-N to achieve 1,030 lb/d monthly average discharge for petroleum refinery wastewaters is through conversion of the existing biological treatment to a nitrification – denitrification activated sludge plant. Based on ADVENT-ENVIRON’s initial design calculations, two additional 1.14 MG tanks would have to be constructed at the Lakefront WWTP for the anoxic portion of the nitrification – denitrification system. With a 30’ height, each of these tanks would require approximately 5,000 $ft^2$ of area per tank, as well as space for additional piping, pumps, and equipment (i.e., estimated total 12,000 sq ft). The BP Lakefront WWTP does not have the available space to accommodate these additional tanks, and placement of these tanks separate of the WWTP would result in extensive piping, pumps, and process inefficiencies making this option extremely expensive, if not, infeasible. As land space is not available at the Lakefront, it is not appropriate to develop capital and operations costs.